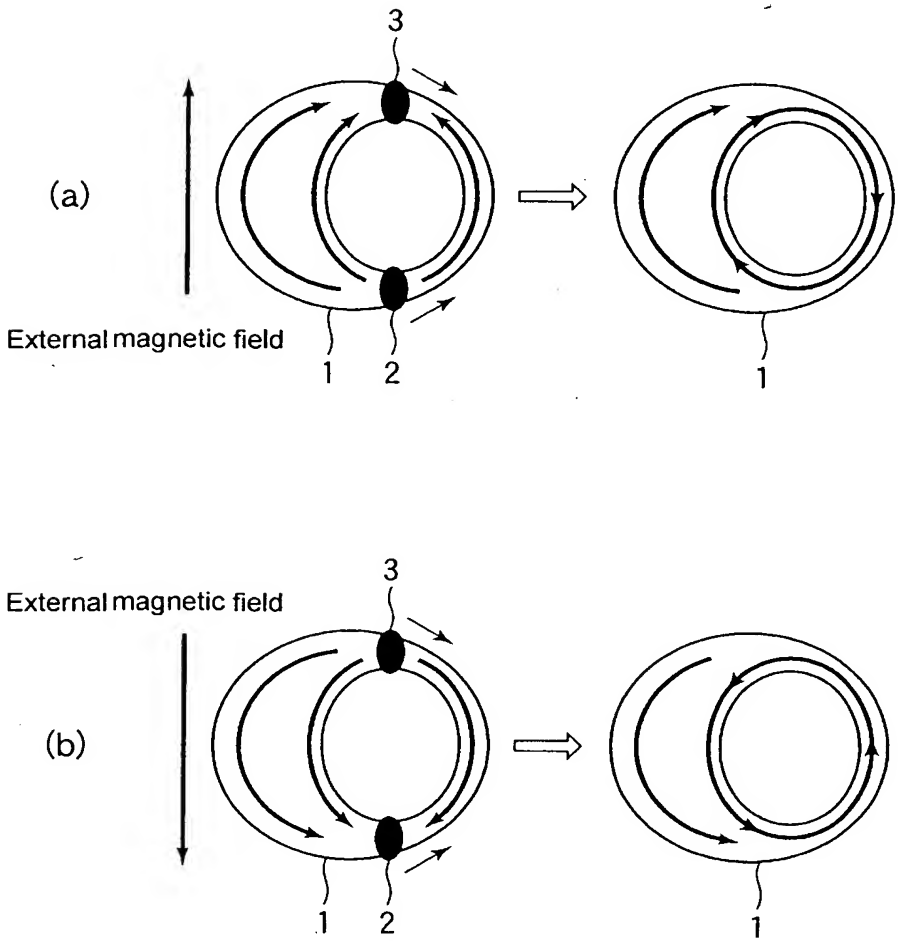
FIG. 1

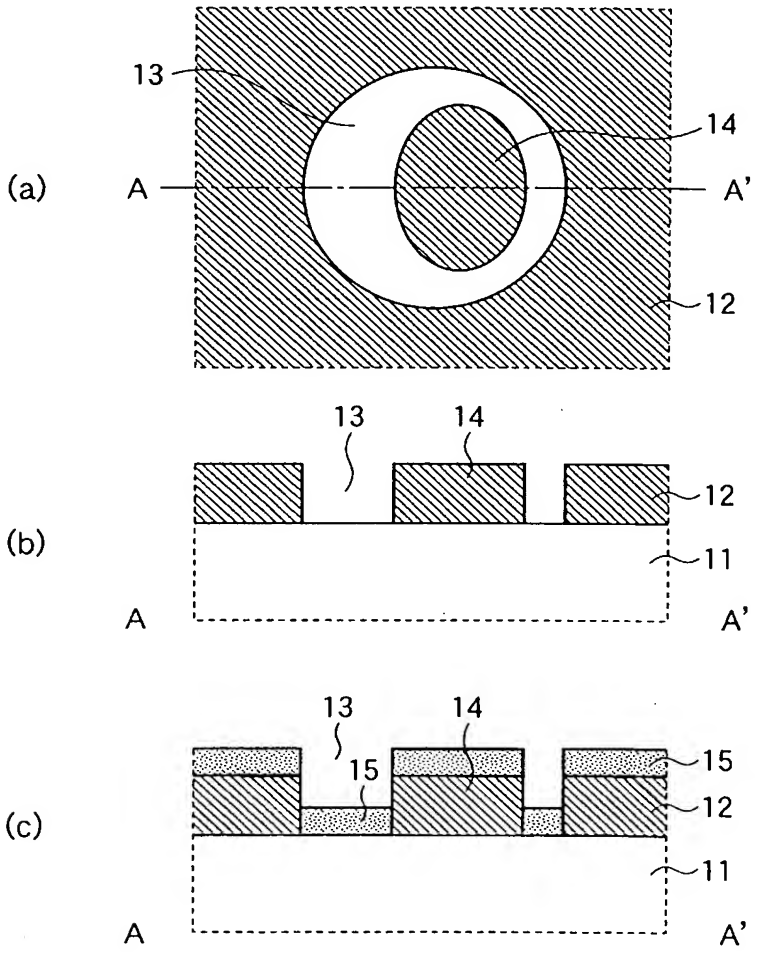
Diagrams describing the configuration
according to the principles of the present invention



1: Magnetic ring 2: Magnetic domain wall 3: Magnetic domain wall

FIG. 2

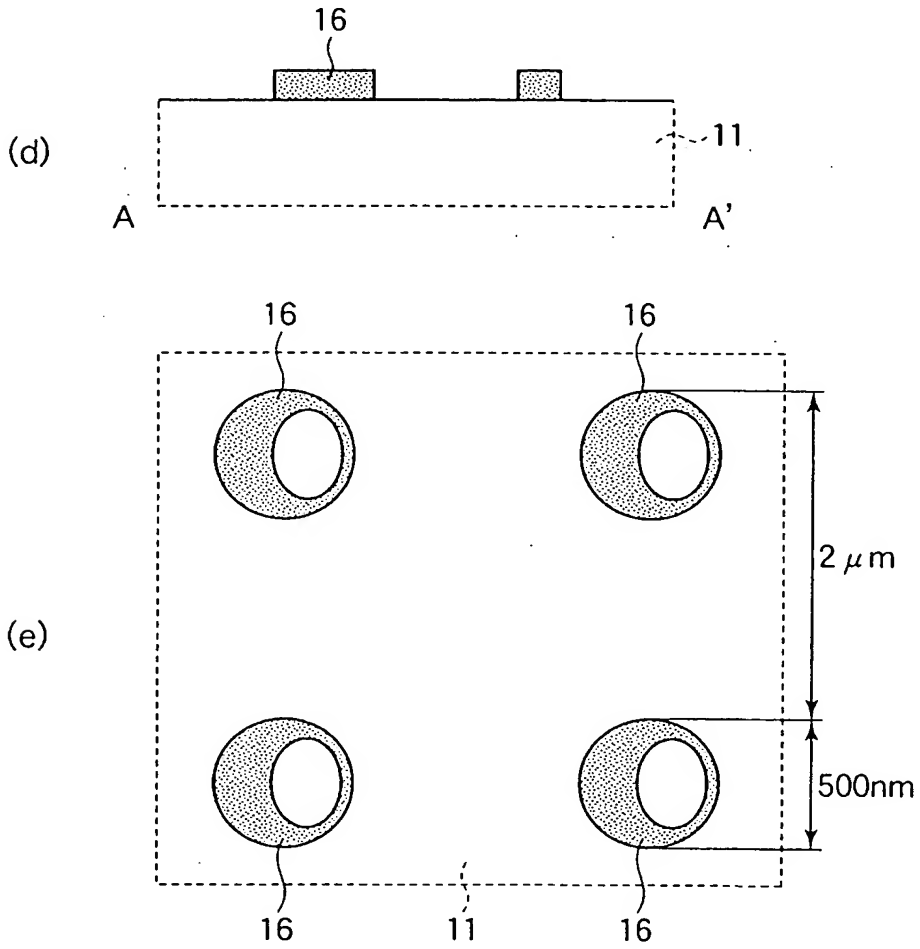
Views describing the steps halfway through the manufacturing of a magnetic ring unit according to the first embodiment of the present



11: Silicon substrate
12: Photoresist layer
13: Recess in ring form
14: Protrusion
15: NiFe layer

FIG. 3

Views describing the steps following Fig 2(c) of the manufacturing of the magnetic ring unit according to the first embodiment of the present invention

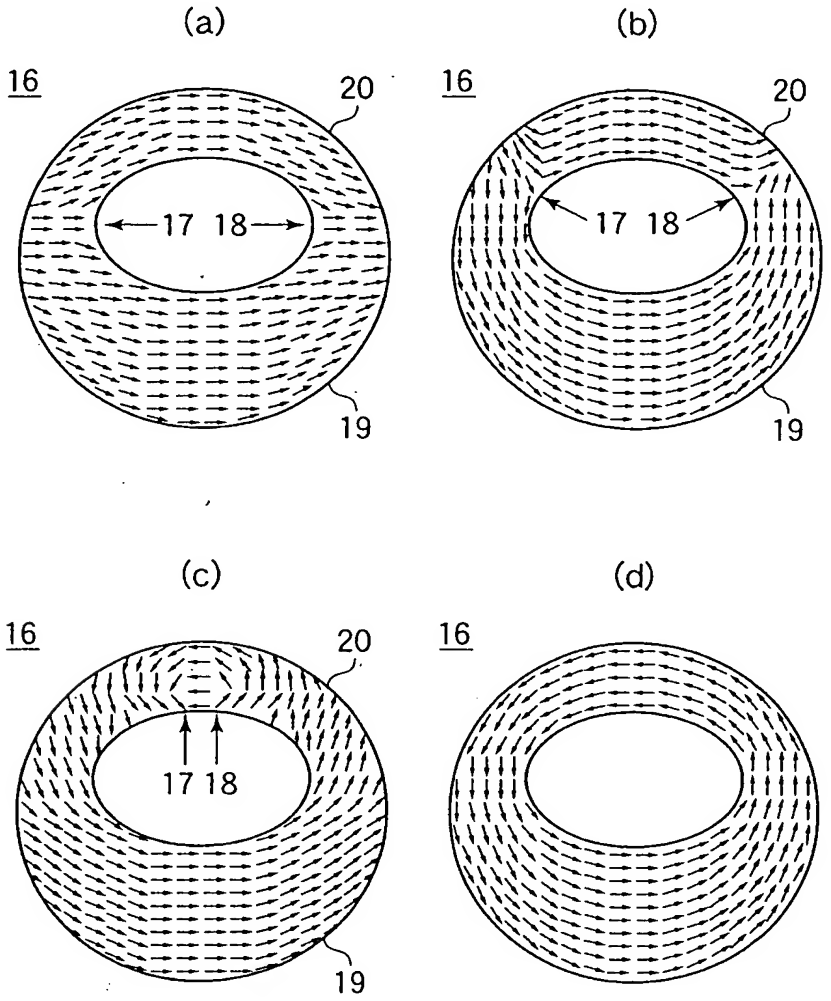


11: Silicon substrate

16: Magnetic ring unit

FIG. 4

Diagrams describing the principles of control of the direction of rotation of the magnetic moment in the magnetic ring unit according to the first embodiment of the present invention



16: Magnetic ring unit
17: Magnetic domain wall
18: Magnetic domain wall
19: Domain with broad ring width
20: Domain with narrow ring width

FIG. 5

Graph describing the hysteresis characteristics of the magnetic ring unit according to the first embodiment of the present invention

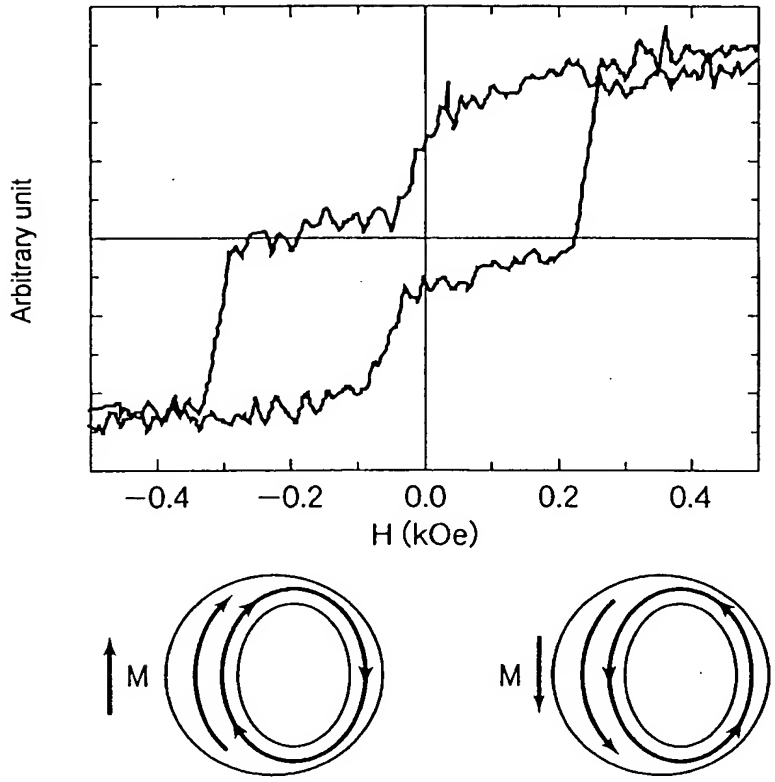


FIG. 6

Graph describing the hysteresis characteristics of a non-eccentric magnetic ring unit according to the prior art

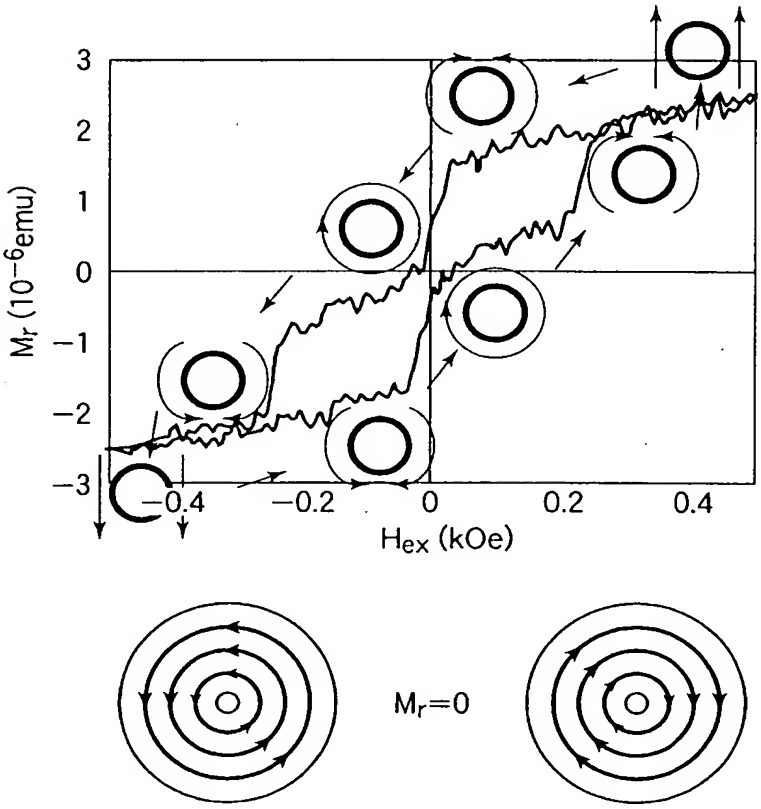
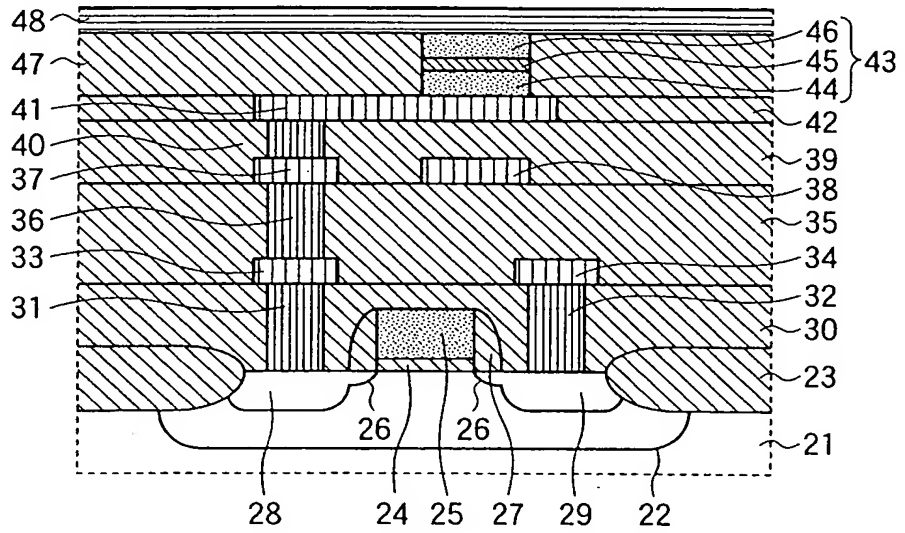


FIG. 7

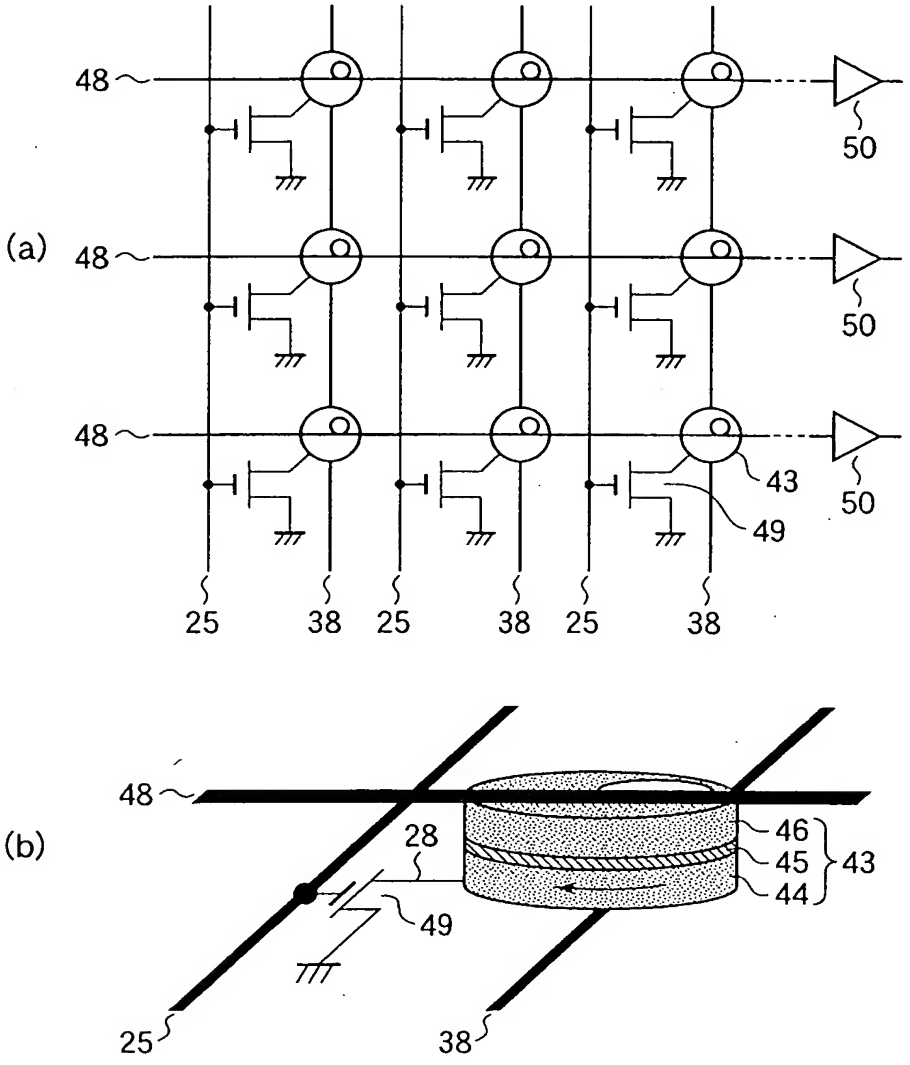
Schematic cross-sectional view showing a main portion of an MRAM according to the second embodiment of the present invention



21: n-type silicon substrate
22: p-type well region
23: Element isolation oxide film
24: Gate insulating film
25: Sense line
26: n^--type LDD region
27: Sidewall
28: n^+-type drain region
29: n^+-type source region
30: First interlayer insulating film
31: W plug
32: W plug
33: Connecting conductor
34: Ground line
35: Second interlayer insulating film
36: W plug
37: Connecting conductor
38: Word line
39: Third interlayer insulating film
40: W plug
41: Lower electrode
42: Fourth interlayer insulating film
43: Magnetic ring unit
44: NiFe layer
45: Tunnel insulating film
46: CoFe layer
47: Fifth interlayer insulating film
48: Bit line

FIG. 8

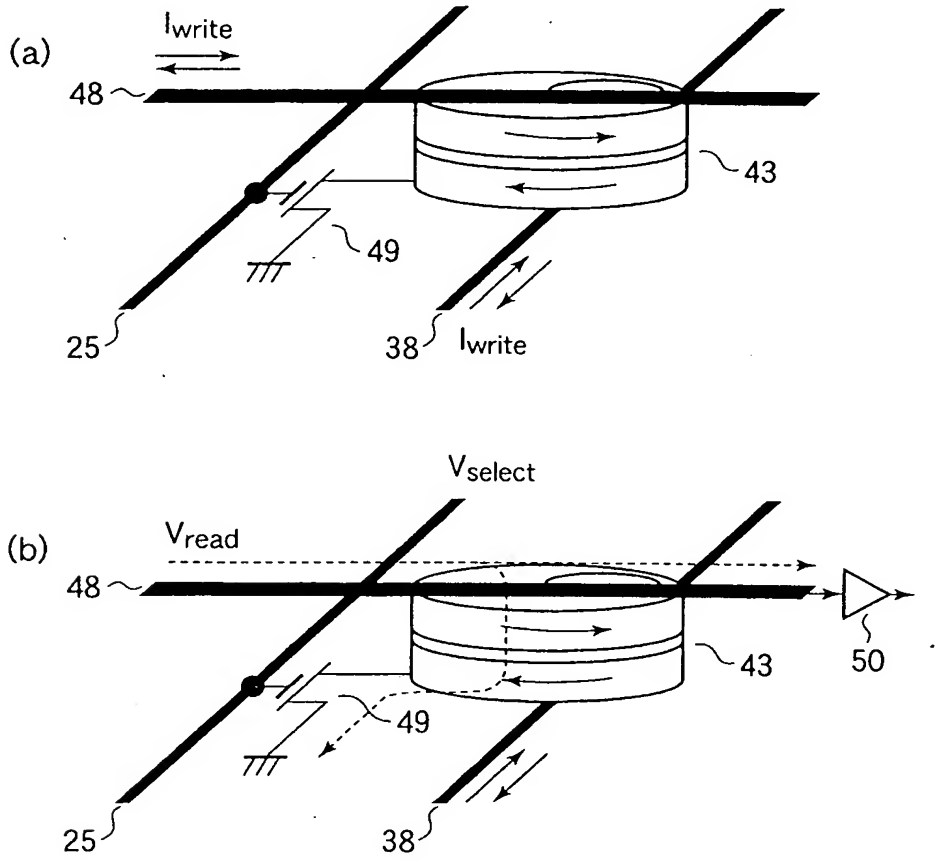
Diagrams describing the circuit configuration of the MRAM according to the second embodiment of the present invention



25: Sense line
28: n^+-type drain region
38: Word line
43: Magnetic ring unit
44: NiFe layer
45: Tunnel insulating film
46: CoFe layer
48: Bit line
49: Access transistor
50: Sense amplifier

FIG. 9

Diagrams describing write-in and read-out operations in the MRAM according to the second embodiment of the present invention



25: Sense line
38: Word line
43: Magnetic ring unit
48: Bit line
49: Access transistor
50: Sense amplifier

FIG. 10

Diagram showing a conceptual configuration of magnetic moment distribution in a nanoring unit

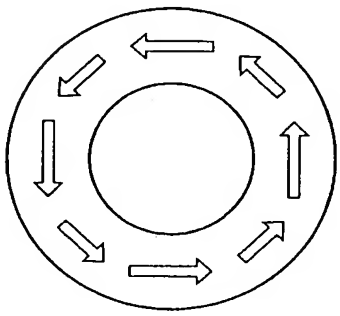


FIG. 11

Diagrams describing the conversion from the opposed domain structure to the magnetic vortex structure in the nanoring unit